

Long-Term Changes in Climate

Objectives

After this lesson, students will be able to

I.4.3.1 Explain the principle that scientists follow in studying ancient climates.

I.4.3.2 Describe the changes that occur on Earth's surface during an ice age.

I.4.3.3 Identify factors that can cause climate change.

Target Reading Skill

Identifying Supporting Evidence

Explain that identifying supporting evidence helps students understand the relationship between the facts and the hypothesis.

Answers

One possible way to complete the graphic organizer under Evidence: Tree rings, pollen, evidence of past glaciers

All in One Teaching Resources

- [Transparency I46](#)

Preteach

Build Background Knowledge

L2

Ancient Climates

Ask: **What do you know about climate changes in Earth's past?** (*Some students might mention past ice ages.*) **How do you think these climate changes might have affected plants and animals?** (*Students might mention that some plants and animals would die out if they couldn't move or adapt to the climate changes.*) Accept all answers without comment.

Long-Term Changes in Climate

Reading Preview

Key Concepts

- What principle do scientists follow in studying ancient climates?
- What changes occur on Earth's surface during an ice age?
- What factors can cause climate change?

Key Terms

- ice age
- sunspot

Target Reading Skill

Identifying Supporting Evidence

As you read, identify the evidence that is used to show that climates change. Write the evidence in a graphic organizer like the one below.

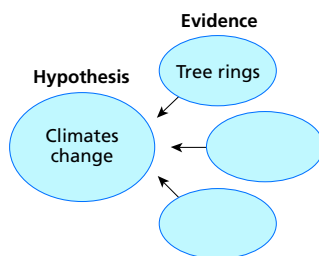


FIGURE 17

Ancient Pueblo Dwellings
The Ancestral Pueblos lived in these buildings, now in Mesa Verde National Park in southwestern Colorado, about 1,000 years ago.



Discover Activity

What Story Can Tree Rings Tell?

1. Look at the photo of tree rings in Figure 18. Tree rings are the layers of new wood that form each year as a tree grows.
2. Look closely at the tree rings. Note whether they are all the same thickness.
3. What weather conditions might cause a tree to form thicker or thinner tree rings?

Think It Over

Inferring How could you use tree rings to tell you about weather in the past?

One of the greatest Native American cultures in the American Southwest was the Ancestral Pueblos. These farming people built great pueblos, or “apartment houses,” of stone and sun-baked clay, with hundreds of rooms, as shown in Figure 17. By about the year 1000, the Ancestral Pueblos were flourishing. Evidence from tree rings indicates that several periods of intense drought then occurred. These droughts may have contributed to a breakdown in their society. By the late 1200s, they had abandoned the pueblos and moved to other areas.

Although weather varies from day to day, climates usually change more slowly. But climates do change, both in small areas and throughout the world. Although climate change is usually slow, its consequences are great.



Discover Activity

Skills Focus Inferring

L1

Materials Figure 18 from student text, magnifying lens

Time Prep 10 minutes (to make photocopies); Class 10 minutes

Tips Enlarge Figure 18 and make photocopies of it. Students can label thick and thin tree rings. If possible, provide students a cross-section of a tree trunk,

for example, a cut from a log used for firewood.

Expected Outcome The tree rings are not all the same thickness. Students might infer that temperature and precipitation affect the thickness of tree rings.

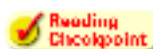
Think It Over The relative thickness of tree rings tells about weather conditions in the past.

Studying Climate Change

Climate changes have affected many regions in addition to the Southwest. For example, Greenland today is mostly covered by an ice cap. But 80 million years ago, Greenland had a warm, moist climate. Fossils of magnolias and palm trees found in Greenland provide evidence for this climate change. Today magnolia and palm trees grow only in warm, moist climates. Scientists assume that the ancestors of these trees required similar conditions. **In studying ancient climates, scientists follow an important principle: If plants or animals today need certain conditions to live, then similar plants and animals in the past also required those conditions.**

Pollen One source of information about ancient climates is pollen records. Each type of plant has a particular type of pollen. The bottoms of some lakes are covered with thick layers of mud and plant material, including pollen that fell to the bottom of the lake over thousands of years. Scientists can drill down into these layers and bring up cores to examine. By looking at the pollen present in each layer, scientists can tell what types of plants lived in the area. From pollen data, scientists can infer that an ancient climate was similar to the climate where the same plants grow today.

Tree Rings Tree rings can also be used to learn about ancient climates. Every summer, a tree grows a new layer of wood just under its bark. These layers form rings, as shown in Figure 18. In cool climates, the amount the tree grows—the thickness of a ring—depends on the length of the warm growing season. In dry climates, the thickness of each ring depends on the amount of rainfall. Scientists study the pattern of thick or thin tree rings. From these data they can see whether previous years were warm or cool, wet or dry.



What are two ways scientists study ancient climates?

FIGURE 18

Evidence of Climate Change

The width of tree rings provides information on temperature and rainfall. A thin ring indicates that the year was cool or dry. A thick ring indicates that the year was warm or wet. **Inferring** Which tree rings would provide information about climate close to the time that the tree was cut down?



Instruct

Studying Climate Change

Teach Key Concepts

L2

Evidence of Climate Change

Focus Remind students that different climate regions have different plants and animals that are adapted to the climate conditions in each region.

Teach Tell students that scientists can identify plant types from pollen grains that are preserved in sediment. Ask: **Where in a lake bottom would the oldest layers of sediment occur?** (*At the greatest depth*) **How could pollen from sediment layers provide information about past climates?** (*Plants in a region might change as climate changes. The layers below a lake bottom record plant changes through time*) **How could tree rings record climate changes?** (*The oldest ring is at the center of a log. Wider rings represent years with good growing conditions, either sufficient rain or warm enough temperatures.*)

Apply Tell students that studies of pollen layers in Georgia and North Carolina have shown that about 25,000 years ago this area had mostly coniferous trees, such as spruce and fir. Ask students to recall the type of climate in which these types of trees grow. (*Cold climates.*) Ask: **What can you infer about the climate in that area 25,000 years ago?** (*The climate was subarctic, like that of much of Canada.*) **learning modality: logical/mathematical**

Independent Practice

L2

All in One Teaching Resources

- [Guided Reading and Study](#)
[Worksheet: Long-Term Changes in Climate](#)

Differentiated Instruction

Gifted and Talented Describing Climate from Tree Rings

L3

Provide students with a cross-section of a log or large branch from your region. Have students determine the order of tree rings from oldest to youngest and infer past climate conditions from the

rings. After students have interpreted the log, have them make a diagram showing temperature and precipitation conditions through time. **learning modality: visual**

Monitor Progress

L2

Oral Presentation Call on students to explain how fossils, tree rings, or pollen are used to learn about climate change.

Figure 18 Those just beneath the bark



Any two: fossil evidence, tree rings, and pollen records

Ice Ages



Discovery
CHANNEL
SCHOOL
Video
Field Trip

Climate and Climate Change

Show the Video Field Trip to let students experience climate and understand climate change. Discussion question: **What major geologic event coincides with the extinction of the woolly mammoth?** (*The Ice Age ended.*)

Teach Key Concepts

L2

Changes on Earth's Surface

Focus Review the definition of a glacier and ask: **Where do we find large glaciers today?** (*On mountains and near the North Pole and South Pole*)

Teach Point out that much of North America was covered by glaciers during the last ice age. Ask: **What evidence might have led scientists to this conclusion?** (*Glacial grooves in rock, deposits of sediment formed by glaciers, and huge boulders that were moved hundreds of kilometers.*)

Apply Ask: **What must the climate in North America have been like at that time?** (*Very cold, similar to climates that exist much farther north today*) **learning modality: verbal**



L2

Modeling Glacier Melting

Materials shallow pan, damp sand, ice cubes or crushed ice, water, toothpicks

Time 20 minutes one day, 5 minutes the next

Focus Tell students that they will construct a model to show why the ocean level rises as ice sheets melt.

Teach Instruct students to use the damp sand to mold a landmass in the shallow pan and to then add water to the pan to simulate the ocean. They can pack the ice on the landmass to represent glaciers. Have students mark the water level at various places on their landmasses with toothpicks and then leave them overnight.

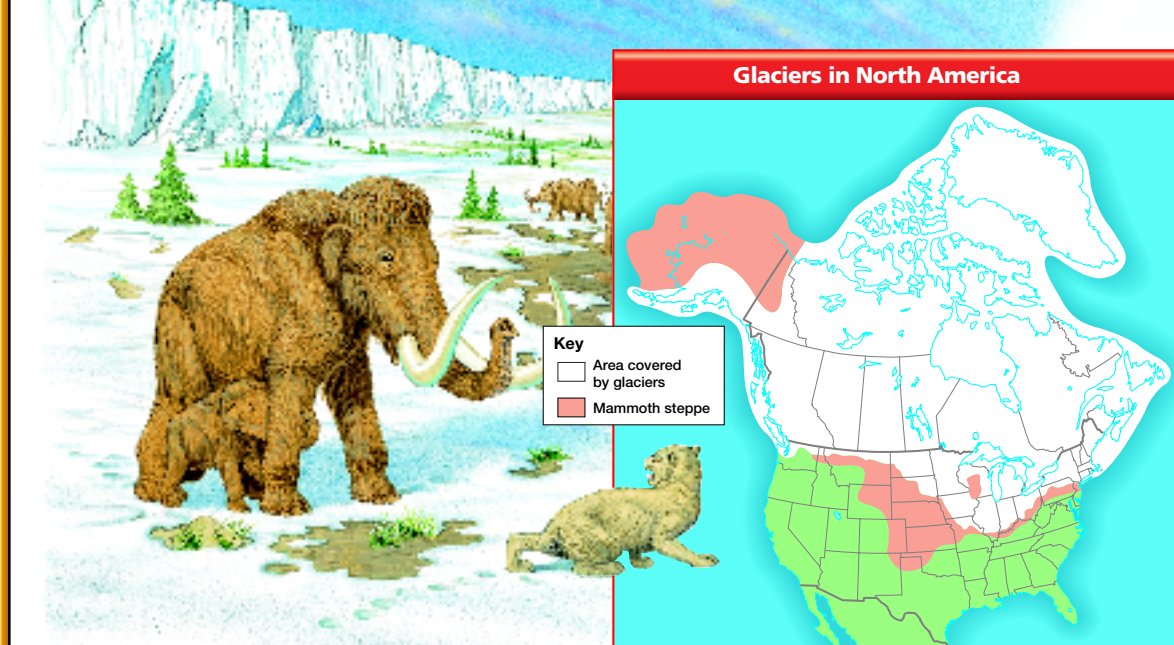


FIGURE 19

The Last Ice Age

The map shows the parts of North America that were covered by glaciers 18,000 years ago. On the steppe near the glaciers lived many mammals that are now extinct, including woolly mammoths.

Ice Ages

Throughout Earth's history, climates have gradually changed. Over millions of years, warm periods have alternated with cold periods known as **ice ages**, or glacial episodes. **During each ice age, huge sheets of ice called glaciers covered large parts of Earth's surface.**

Glaciers transform the landscape by carving giant grooves in solid rock, depositing enormous piles of sediment, and moving huge boulders hundreds of kilometers. From this evidence and from fossils, scientists have concluded that in the past two million years there have been many major ice ages. Each one lasted 100,000 years or longer. Long, warmer periods occurred between the ice ages. Some scientists think that we are now in a warm period between ice ages.

The last ice age ended only about 10,500 years ago. Ice sheets covered much of northern Europe and North America, reaching as far south as present-day Iowa and Nebraska, as shown in Figure 19. In some places, the ice was more than 3 kilometers thick. So much water was frozen in the ice sheets that the average sea level was much lower than it is today. When the ice sheets melted, the rising oceans flooded coastal areas. Inland, the Great Lakes formed.



Why were the oceans lower during the ice ages than they are now?



Apply The next day, have students observe the water level. Ask: **How does this model show why the level of water in the oceans is higher now than during the last ice age?**

(*Less water is frozen in glaciers, so more liquid water is available for oceans.*) **learning**

modality: kinesthetic

Causes of Climate Change

Why do climates change? Possible explanations for major climate changes include variations in the position of Earth relative to the sun, changes in the sun's energy output, major volcanic eruptions, and the movement of the continents.

Earth's Position As Earth revolves around the sun, the time of year when Earth is closest to the sun shifts from January to July and back again over a period of about 23,000 years. The angle at which Earth's axis tilts and the shape of Earth's orbit around the sun also change slightly over long periods of time. The combined effects of these changes may be the main cause of ice ages.

Solar Energy Short-term changes in climate have been linked to changes in the number of **sunspots**—dark, cooler regions on the surface of the sun. Sunspots increase and decrease in fairly regular 11-year cycles. Satellite measurements have shown that the amount of energy the sun produces increases slightly when there are more sunspots. This may cause Earth's temperature to warm.

Volcanic Activity Major volcanic eruptions release huge quantities of gases and ash into the atmosphere. These materials can stay in the upper atmosphere for months or years. Scientists think that the gases and ash filter out some of the incoming solar radiation, and may lower temperatures.

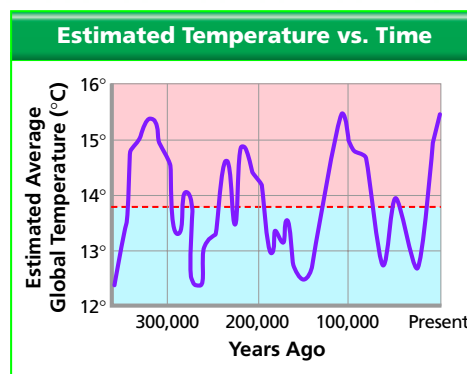
Math

Analyzing Data

Ice Ages and Temperature

The graph shows the estimated average worldwide temperature over the last 450,000 years. During this time, cold glacial periods (blue) alternated with warmer interglacial periods (pink).

1. **Reading Graphs** What does the x-axis of the graph represent? What does the y-axis represent?
2. **Interpreting Data** What pattern do you see in these data? How would you explain this pattern?
3. **Predicting** Based on the pattern over the last 400,000 years, predict how global temperature will change in the future.



Causes of Climate Change

Teach Key Concepts

L2

Climate Change

Focus Have students imagine huddling around a heater on a cold day. Ask: **What could you do to change the amount of heat that reaches you?** (*Move closer to the heater, turn up the heater, tilt your body in a different way, block some heat energy*) Tell students that these same things can cause climate change on Earth.

Teach Explain the four causes of climate change that are covered in the textbook. Then ask: **Which of these stops some of the sun's energy from getting to Earth?** (*Volcanic activity*) **Which causes the sun to emit more or less energy?** (*Sunspots*) **Which causes climate change by changing the distance and orientation of Earth compared to the sun?** (*Earth's position*)

Apply Ask: **Which of these could cause climate change during your lifetime?** (*Sunspots, Volcanic activity*) **learning modality: verbal**

Math

Analyzing Data

Math Skill Making and interpreting graphs

Focus Help students understand that line graphs are useful to show continuous data.

Teach Ask: **What is the dark curving line?** (*This line shows average global temperature at different times.*) **What is the dashed line?** (*This line shows the average for all the data.*)

Answers

1. Number of years ago, estimated average global temperature in degrees Celsius
2. Periodic ups and downs in average global temperature; the temperature changes represent ice ages and warmer times in between, these changes may have been caused by changes in Earth's position in space
3. The pattern probably will continue. Global temperatures are relatively high now, so they may decrease in the future, all else equal. Earth eventually will have another ice age.

Monitor Progress

L2

Writing Have students explain what an ice age is and how one might occur.

Answer



A lot of water was stored in the ice on land.

Monitor Progress L2

Answers

Figure 20 Gondwanaland: South America, Africa, Australia, and Antarctica; Laurasia: North America, Europe, and Asia.



A large single continent that existed about 225 million years ago

Go online
active art

For: Continental drift activity

Visit: PHSchool.com

Web Code: cfp-1015

Students can interact with the art about Pangaea online.



225 Million Years Ago



180—200 Million Years Ago

FIGURE 20

Moving Continents

The continents have moved over millions of years.

Interpreting Maps Which present-day continents broke away from Gondwanaland? Which broke away from Laurasia?

Go online
active art

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Web Code: cfp-1015

Movement of Continents The continents have not always been located where they are now. About 225 million years ago, most of the land on Earth was part of a single continent called Pangaea (pan JEE uh), as Figure 20 shows. At that time, most continents were far from their present positions. Continents that are now in the polar zones were once near the equator. This movement explains how tropical plants such as magnolias and palm trees could once have grown in Greenland.

The movements of continents over time changed the locations of land and sea. These changes affected the global patterns of winds and ocean currents, which in turn slowly changed climates. And as the continents continue to move, climates will continue to change.



What was Pangaea?

Assess

Reviewing Key Concepts

- a.** If plants or animals today need certain conditions to live, then similar plants and animals in the past also required those conditions. **b.** Fossil evidence, tree rings, pollen records **c.** The weather was very dry or very cool during those years.
- a.** A huge sheet of flowing ice **b.** Glaciers cover large parts of Earth's surface. **c.** During an ice age, the climate was colder than it is today.
- a.** Earth's position relative to the sun, changes in the sun's energy output, volcanic activity, and movement of continents **b.** Any one: Earth's position or tilt of its axis relative to the sun can increase or decrease the amount of solar radiation Earth receives. Energy output from the sun is lower during sunspot minima. Ash and gases from volcanic eruptions can block some incoming solar radiation and cause cooler temperatures. Movement of continents affects how much solar energy they receive and can affect global wind patterns and ocean currents, which in turn can change climate.

Reteach

As a class, make a chart that lists and briefly describes evidence of climate change and causes of climate change.

All in One Teaching Resources

- Section Summary: *Long-Term Changes in Climate*
- Review and Reinforce: *Long-Term Changes in Climate*
- Enrich: *Long-Term Changes in Climate*

Section 3 Assessment



Target Reading Skill

Identifying Supporting Evidence Refer to your graphic organizer about the hypothesis that climate changes as you answer Question 1 below.

Reviewing Key Concepts

- a. Reviewing** What principle do scientists follow in studying ancient climates?
b. Describing What types of evidence do scientists gather to study changes in climate?
c. Inferring Suppose that you are a scientist studying tree rings in a cross-section of an ancient tree. What could several narrow tree rings in a row tell you about the climate when those rings were formed?
- a. Defining** What is a glacier?
b. Explaining What occurs during an ice age?
c. Comparing and Contrasting Compare the climate today with it during an ice age.

- a. Listing** What are four factors that could be responsible for changing Earth's climate?
b. Summarizing Select one of the four factors that could cause climate change and summarize how it may cause the climate to change.

Writing in Science

Procedure for Data Collection Suppose that you are a scientist who wants to use pollen data from a lake bed to learn about ancient climates. Write the steps for the procedure that you would follow to collect and analyze your data.



Chapter Project

Keep Students on Track Check that students have enough data recorded in their logbooks to begin graphing and analyzing it. Suggest that they construct tables or graphs to help them compare and contrast their observations. Encourage students to think about which climate factors caused the weather data to be different in each microclimate.

Writing in Science

Scoring Rubric

- Explains that a sediment core is drilled, samples spaced through the core are studied under a microscope, pollen types are identified and counted, and pollen types are used to infer climate changes.
- Correctly describes most of the procedure
- Description omits important details
- Incorrectly describes the procedure